The abstract thinking levels of the science-education students in Gaza universities

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Contents

Abstract

The purpose of this study was to determine the abstract thinking levels of the science students attending the first and fourth year at two Palestinian Universities (Al-Aqsa and Al-Azhar). The sample consisted of 133 students from Science Education Departments (SE). The tool, used to measure abstract thinking, was one of the Science Reasoning Tasks developed by the CSMS in UK in 1994. The results showed that almost 65% of the 4th year science-education students was at levels

capable of formal operational thought. However, only a very small minority showed capability of late formal operational thought (3.6%). About 30% of the 4th year students were at concrete thinking levels. In the first year, there were only 40% of the students who had formal thinking level and about 60% had concrete thinking level. The results showed a positive correlation between the scores of the students in the abstract thinking test with the achievement level in the universities (GPA). The results proved that there was a gap in the levels of abstract thinking, between the current thinking level and the expected one of the students. The students-teachers have not reached the minimum abstract level at which a science teacher should be, in order to teach high school science in the future. The results may be partially considered an evident of existence of unsuitable selection of students in SE Departments in the two universities. More data are needed in that regard. Generally, we may conclude that, the current systems in Science-Education Departments have not succeeded in assisting the students to reach their potential in terms of cognitive ability through four years of teachers preparation program. Some recommendations are included in the study.

Keywords: abstract thinking, science education students, Al-Azhar and Al-Aqsa Universities, Gaza Palestine.

Introduction

Measurement and Assessment department in the Ministry of Education in Palestine showed some data on the past examination records of the National Examinations in the last five years, 2007-2012. The report showed continuous unacceptable performance in mathematics and science. This is followed by the poor results of TIMSS in 2007 and 2011 in Palestinian territories.

These numbers revealed a dangerous deterioration in science and mathematics education in our schools. According to the GSSC data, the percentage of students who joined Science Field in the Secondary schools in 2013 was 18%. However, the percentage of science students in secondary schools was 75% in 1995. Students continue escaping from science field toward humanity fields.

Several studies were done to investigate the reasons which stand behind this deterioration in the results of National Examinations and TIMSS. Many educational

aspects were studied to clarify the problem in science results, but few studies focused on science teachers preparation programs and the gained skills in the university. This approach leads to discuss the selection process of students at colleges of education in some Palestinian universities.

Science teacher must be carefully selected. College of Education must select the best students to join the Department of Science Education. Internationally, some Colleges of Education depend on GSSC[1] scores in selecting their student-teachers, while others depend on entrance examinations, which may include investigating the thinking skills and intellectual abilities of the candidates.

However, in most of the Palestinian Universities, the criteria used in selecting candidates depend on the GSSC scores only, which does not always reflect the ability to work as science teachers in the future.

Thinking abilities of the new science teachers are one of the indicator of how the preparation program is doing, what the selection standards look like in practice, and how students are doing in relation to expectations. "Abstract thinking is one of the thinking skills, which is necessary for good science teacher" (Adey, and Shayer, 1994). Also, critical thinking and reasoning are two thinking skills needed for teachers in general (Afana, 1998).

Abstract thinking level is highly related to academic achievement. How student understand and learn depends on their cognitive processing capability and abstract thinking level. The results of researches in the same field confirm that the high abstract thinking levels do predict good achievement in mathematics and science (Shayer, 1999:10).

The ability to think abstractly has long been considered a core skill for different teachers. Literature confirm that, science teacher must have a high level of abstract thinking, that may facilitate teaching science and abstract concepts properly (Harb and Darwish, 2005). The ability to think abstractly is associated with the ability to transfer what is learned from one context to another (Ylvisaker and Hibbard , 2008). In general, abstract thinkers students are able to reflect on events, ideas, and

[1] GSSC stands for General Secondary School Certificate.

relationships. They can perform deductive and inductive reasoning, analyze possibilities and utilize abstract ideas (Velasquez, 2013: 34).

The Palestinian Curriculum Analysis Taxonomy in secondary and intermediate schools, demands formal operational processes (Darwish, 1998, Darwish, 2001). Consequently, formal thinking is required for science teachers as well as students. So, the tests used entrance examination in some colleges of education in USA depend on investigating the student's use of higher-order mental processes such as the hypothetic-deductive reasoning and logic (Dunn, 2006; Ginsburg and Opper, 1988).

The current study tries to find the abstract thinking levels of student-teachers in science departments, this may help to partially predict whether the selection process in the university produces the best candidates for science teachers in the light of possessing some necessary thinking abilities or not. Particularly, it tries to investigate whether the student-teachers have some of the required thinking skills for teaching science in the future. Also, the study tries to investigate the relationship between the abstract thinking level and the achievement in science for student-teachers in the Department of Science Education.

The present study

Statement of the problem

Intellectual abilities of student- teachers may be considered as one of the evidences of how teacher preparation program is doing, what our selection standards look like in practice, how students are doing in relation to expectations, and if the universities have already selected the best candidates to be science teacher in the future (Astin, 1997). Literature considers the abstract thinking ability one of the important requirements for effective teaching of science. So, it was used to partially assess some aspects of the selection process in some universities to guarantee the enrollment of the best candidates for Colleges of Education.

Consequently, the specific purpose of this study was to determine the cognitive developmental profile of science students in Al-Azhar and Al-Aqsa Universities in order to determine the proportions of students who have abstract thinking level in the Science Education Department. This was done to determine whether the science students had all reached their optimum cognitive developmental level and hence

have the ability to understand and teach science concepts as proposed by the literature or not. The result will help us to assess our selection criteria of the student-teachers in the College of Education. The specific questions of the study are:

1. What are the abstract thinking levels of the students of science education in Al-Azhar and Al-Aqsa Universities?
2. Are there any statistical differences at level ($\alpha \leq 0.05$) between the average score of first- year students and the fourth -year students on Science Reasoning Tasks?
3. Is there any statistical relationship between the abstract thinking level and the achievement in science for student- teachers in the Department of Science Education?

The significance of the study

1. The result of the study will be used as an indicator of the success of selection process of the college candidates in the Science Education Department. So, it may be considered as one source of assessing the Teachers Preparation Program (TPP) in science in Al-Azhar and Al-Aqsa Universities. Consequently, the study may reveal some causes of deterioration in teaching science through assessing the intellectual abilities of the science teachers.
2. The current study is considered one of the few studies which examined the thinking levels for the university students in Palestine.
3. The study introduces a translated copy of abstract thinking test (SRTs) which is used in several countries.

Objectives of the study

1. The study tried to determine the abstract thinking levels of sample of the students of Science Education Department in Al-Azhar University and Al-Aqsa University.
2. The study tried to find if there are any statistical differences at ($\alpha \leq 0.05$ level) between the average score of Al-Azhar and Al-Aqsa first year students on Science Reasoning tasks (SRTs) or not.
3. The study tried to find if there are any statistical differences between the average score of first year and the fourth year students on Science Reasoning Tasks (SRTs) or not.

4. The study tried to find if there is any statistical relationship between the abstract thinking level and the achievement in science for student- teachers in the Department of Science Education or not.

Hypotheses

The claims being investigated are that:

1. There are no statistical differences at ($\alpha \leq 0.05$ level) between the average score of Al-Azhar and Al-Aqsa first year students on Science Reasoning tasks (SRTs).
2. There are no statistical differences at ($\alpha \leq 0.05$ level) between the average score of Al-Azhar and Al-Aqsa fourth year students on Science Reasoning Tasks SRTs.
3. There are no statistical differences at ($\alpha \leq 0.05$ level) between the average score of first year students and the fourth year students on Science Reasoning Tasks SRTs.
4. There is statistical relationship at ($\alpha \leq 0.05$ level) between the abstract thinking level and the achievement in science for student- teachers in the Department of Science Education.

Study delimitation

The study was carried out in Al-Azhar and Al-Aqsa Universities in Gaza in Palestinian territories, in the second semester 2013/2012. The target group is the students of the Science-Education Department in the first and fourth year (see sample). The British SRTs test was used to determine the abstract thinking levels or cognitive development level of the university students of the Science-Education Department (the target group).

Theoretical framework

Piaget introduced his biologically motivated work early in the last century, and from that time until today, educators and researchers have eagerly worked to exhibit a link between students' development level and their capacity for learning. Researches from different cultures considered that Piaget was right about many important aspects of cognitive development. In general, children move from being less systematic and less able to reason logically to being more able to think in these

ways. Children seem to pass through Piaget's four stages in the same order, although the age brackets of the stages show some variability. Also, reaching formal thinking stage depends on several different factors such as educational levels, the kinds of cognitive skills valued in a given culture, and biological aspects (Markwell & Courtney, 2006). Abstract thinking in the formal thinking stage is developed at 14 to 17 years of age, usually after some degree of education.

According to Piaget, cognitive development level reaches its fullest potential thought during adolescent period. Major changes occur in this stage: Adolescents gradually develop the ability to use hypothetic-deductive reasoning, and they extend their logical thinking to concepts that are abstract. For Piaget, the culminating achievement of cognitive development is the ability to use abstract thinking and hypothetic-deductive reasoning. Hypothetic-deductive reasoning is the use of deductive reasoning to systematically manipulate several variables, test their effects in a systematic way, and reach correct conclusions (Cook and Cook , 2005).

Velasquez (2013) defined the Cognitive Development, as: The process of acquiring thinking skills and increasingly advanced intellectual thought with ability to use problem-solving approach in life situations from early school to adulthood. Also, cognitive development is defined as "the individual's use of higher-order mental processes such as reasoning and logic" (Astin, 1997, p. 9). Cognitive development profile reveals the levels of the abstract thinking ability of the individuals. It could be measure through using a number of well-known intellectual tasks (Dunn, A. 2006; Ginsburg & Opper, 1988). Abstract thinkers can easily remove unnecessary details from scientific situation, generalize concepts, and discover patterns (Roberts , 2010). Individuals in the concrete operational stage are not good at systematically testing all of the factors affect in the experiment. Individuals using formal operations, however, start by considering all of the variables and all of their possible combinations, reasoning that any one factor could be responsible for the results. Students systematically test each factor one at a time, holding the other factors constant, until they arrive at the correct solution. The individual shows hypothetic-deductive reasoning, or formal scientific reasoning . That means she/he has the ability to plan tests with multiple variables. Our SRT test in the current study used the same strategy.

Cognitive development and capacity for learning science

Educators have eagerly worked to exhibit a link between students' development level and their capacity for learning. The two levels which most college students are operating are concrete operations and formal operations. With the achievement of hypothetic -deductive reasoning and abstract thought, students gradually attain what Piaget considered mature cognition. They become able to reason about anything, real or imagined, and have the capability to use scientific reasoning to solve relatively complex problems. But this does not mean that no further changes in cognition will occur. Piaget claimed that we never reach a permanent state of equilibrium. He believed that we are forever adapting and reorganizing our cognitive structures and working "toward better equilibrium" (Piaget, 1985: 26).

The science students who are in the concrete operational stage have difficulties in understanding science concepts. These students may make it through the curriculum by rote learning. Understanding science concepts requires formal operational thoughts or abstract thoughts. There are 30 to 60 percent of the adult population who have some trouble with formal operational thought. Studies mentioned that close to half of entering college students are not operating at advanced stages of cognitive development (Foster, Bookman and, Whittington, 2010). Students may be unable to work the scientific problem either because of lack of knowledge or because of an inability to solve abstract problems. The university and postsecondary education may play a key role in exposing students to experiences that enhance the development of abstract thinking. That means the education system may be not significantly contributing to the intellectual development of students in schools or university. In other words, it does not succeed in developing or enhancing the abstract thinking and logical reasoning of students (Foster, Bookman and, Whittington, 2010). Woolfolk (2007) stated, "Some students remain at the concrete operational stage throughout their school years, even throughout university". That means we may find the first year university students who does not show mature formal thinking yet. This was shown in several studies such as: (Magoshi , 1991 ; McCormack et cl, 2009).

Assessing Abstract thinking

The study used Science Reasoning tasks (SRTs). McCormack and others (2009) used the same test (SRTs) to investigate the cognitive development level of the new student-teachers in the colleges of education in Ireland. Also, Magoshi (1990) used a similar approach to reveal the thinking skills of students teachers in King Saud University in the KSA.

Several tools were developed by the Concepts in Secondary Mathematics and Science (CSMS) team and were called the Science Reasoning Tasks (Adey and Shayer, 1994). Their function was to assess the ability of individuals to use concrete and formal reasoning strategies, as described by the Piagetian stages. Each stage of cognitive development was divided into late and early stages. Adey and Shayer (1994) use the notation shown down to indicate stages and sub-stages of the cognitive development scale.

Table 1. Stages of development and corresponding Age (years)

Stage of Cognitive Development	Piagetian Level Notation	Approximate Age -years
Pre-operational	1	Less than 5
Early concrete operational	2A	5/6
Mid concrete operational	2A/2B	7/9
Late concrete operational	2B	10/11
Transitional/concrete generalization	2B/3A	
Early formal operational	3A	11/13
Formal generalization	3B	Begin 14/15 y

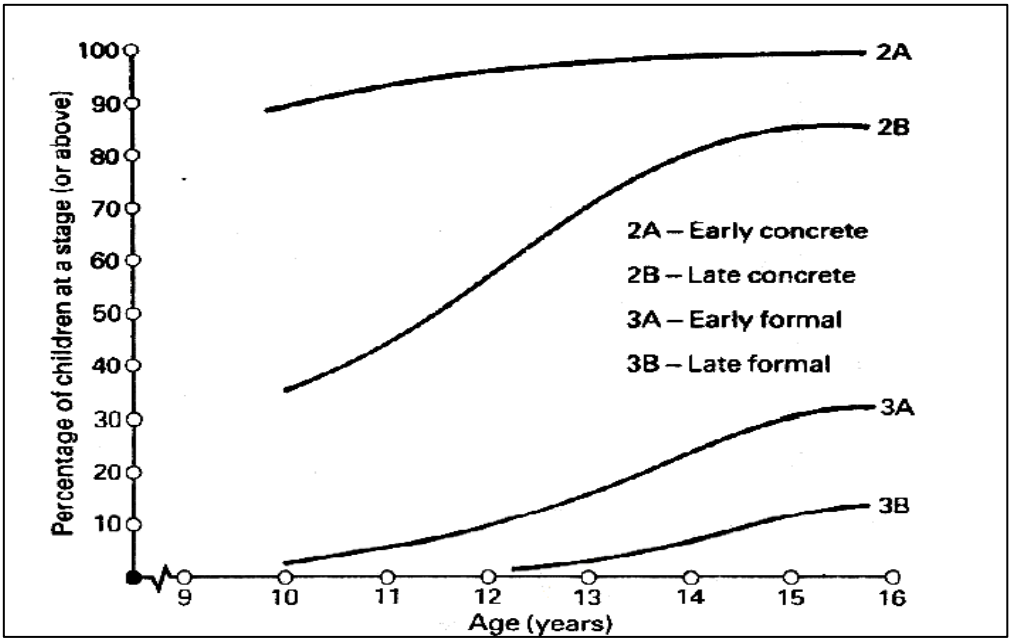

Figure 1. Results from the CSMS survey in UK show the proportion of children at different Piagetian stages in a representative British population (McCormack and et al., 2009).

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Literature review

Abstract thinking has long been considered a core skill for many scientists. Many studies tried to gather evidence about the link between abstract thinking skills and success in Science discipline. The results in several studies showed a positive correlation between the scores of the students in the abstract thinking with the scores achieved in university science (Roberts, 2010; Armoni and Gal-Ezer, 2007; and Bennedsen and Caspersen , 2006). Kramer (2007) has called abstract thinking the “key skill” in understanding and teaching science.

In Ireland, McCormack, Finlayson, and Castle (2009) studied the cognitive developmental levels of a Sample of First Year University Science Students. The purpose of the study was to gauge the cognitive developmental levels of first year university science students. The sample consisted of 386 third-level students. The task used to measure the cognitive developmental levels was one of the Science Reasoning Tasks, developed by the CSMS team. The profile obtained showed that almost 70 per cent of students were at levels capable of formal operational thought. However, only a very small minority showed capability of late formal operational thought. Thirty-two per cent of the university cohort was at concrete levels of cognitive development.

In Turkey, Salih, et al. (2004) studies the students' cognitive development levels. The aim of the study is to determine the relationship between students' cognitive development levels and their science achievement using the Science Cognitive Development Test (SCDT). The sample were 445 students. A positive relationship was found between cognitive level and achievement in science.

In China, Zhang and Watkins (2001) studies the cognitive development and student approaches to learning: The purpose of their research was to provide cross-cultural evidence of the relationship between student approaches to learning and stages of

cognitive development. The participants for this study were 67 U.S. and 193 Mainland Chinese students. There were four major findings. First, cognitive development and student learning approaches were related in predictable ways. Second, the cognitive-developmental patterns of the American and Chinese participants differed. Third, for both American and Chinese students, extracurricular activities positively contributed to their cognitive development. Finally, a statistical significant relationship between cognitive development and achievement was identified among the American group, whereas no relationship was found between cognitive development and achievement among the Chinese group. Implications of these findings are discussed.

In KSA, Maghoshi (1990) investigated the cognitive development level of university student in College of Education in Riyadh. The results showed that 30% of the first year students have formal operational thought.

In Palestine no studies have been done to investigate the cognitive developmental profile for university students. Afana, (1998) studied only the critical thinking in some Palestinian universities. He confirmed the importance of the intellectual abilities criteria for selecting university students in colleges of education. There are other types of studies concentrated on enhancing cognitive development and abstract thinking level of students. For example, Velasquez (2013) tried to improve the students' cognitive development level by applying new methodologies depending on the use of critical thinking and mind mapping activities and other active learning approaches. She tried to stimulate reasoning and cognitive development of students of English (ESL) at Cocle University. Half of the samples presented an improvement in their cognitive development level.

Methodology

a. Study Approach

To investigate the abstract thinking level of the university students in Science Education Department, the descriptive analytical approach was selected as the most appropriate method to fulfill the aim of the study.

b. Study Subjects

The study subjects are 133 students from Science Education Department from Palestine. There are 53 student-teachers from Al-Aqsa University and 80 student-teachers from Al-Azhar University, in Gaza. The sample of the study was about 60% of the society.

Table 2. Subject of the study

Year/Level	Al-Azhar	Al-Aqsa	
4th year	55	27	
1st year	25	26	
Sub-total	80	53	
Total No of Students			133

c. Instrument and Administration

The tool selected to assess the abstract thinking (or cognitive levels) of the students was the "SRTs- SP". It is one of the SRTs series. This task assesses cognitive development levels between the ranges of mature concrete (2B) and formal generalization or abstraction level (3B). The task contains thirteen items and investigates the student's ability to manage and control variables. Towards the end of the task, the problems raised in the test need a late formal thinker (appendix 1).

Scoring: The method of ascribing a level of cognitive development (Abstract thinking) to student has been made simpler and more reliable. Examiner can make assessment simply on the total number of items that a subject/student has answered correctly; and the level of development is expressed directly as a number on scale (table. 3). Students' responses are given scores of either `1' if correct or adequate and `0' if incorrect. The final score each student obtained was matched with the corresponding numerical scale and Piagetian level, representative of the student's stage of cognitive development (Table. 3).

Table 3. Scoring system for Science Reasoning Tasks – the Simple Pendulum

Total no. of right items	The scale /corresponding score	Classification /Cognitive Developmental (Abstract.) level	
1	5.2	Mature Concrete	2B
2	5.7	Mature Concrete	2B
3	6.1	Concrete Generalization	2B*

4	6.4	Concrete Generalization	2B*
5	6.7	Concrete Generalization	2B*
6	7	Early formal	3A
7	7.2	Early formal	3A
8	7.4	Early formal	3A
9	7.7	Early formal	3A
10	8	Mature formal	3A/3B
11	8.4	Mature formal	3A/3B
12	8.9	Mature formal	3A/3B
13	9.8	Formal generalization	3B

d. Development and Verification of the instrument

This SRTs test, as well as the others in the series, was evaluated in a rigorous manner by the CSMS team in terms of their reliability and validity. The reliability of the tests was investigated in two ways. The internal consistency was measured by the Kuder-Richardson coefficient (rtt), and the value obtained for the task was 0.86.

Detailed studies of content, construct, concurrent and predictive validities have been carried out and reported by CSMS team (McCormack, et al, 2009). The Cronbach's Alpha coefficient for the used tool (SRTs) was 0.7, deeming it to be internally consistent.

e. Translation of study tool (SRTs) to Arabic Language

The researcher translated the current SRTs test to Arabic language. The content validity of translation was examined through reviewing the translated copy by three professors from colleges of education. Some modifications in translation were done to have clear meaning of the content.

f. Reliability of the Arabic copy of the SRTs

Test-retest reliability method was used to measure the tool reliability (the extent to which a task will tell the same story on two successive occasions). The same students (outside the sample) were given the same task twice within a three weeks. Correlation between the two values was done to determine the value of correlation

coefficient "r". The reported value for "r" was 0.84, which is a good value for such a type of research.

Results and discussion

Question 1: What are the abstract thinking levels of the first –year students of Science Education Department (SE Departments) in Al-Azhar and Al-Aqsa Universities? The Science Reasoning Tasks Test (SRTs) was implemented on the first year students in SE Department of Al-Azhar University. The Cognitive developmental levels are displayed in table 3 and 4. It can be seen that 40% of the science education students at Al-Azhar University are at the formal operational level (abstract thinking level), with the majority at the concrete level. There were only 8% at the Mature formal (3A/3B) level (Table-4). The percentage of the students who have formal operational level in Al-Aqsa University is 42%, which is not far away from Al-Azhar percentage (Table- 5).

Table 4. Cognitive development levels of Al-Azhar students -first year (Science Education)

Developmental stage	symbol	Frequency: No. of students	Percentage	Abstract/ Concrete
Mature Concrete	2B	3	12%	60% Concrete thinking
Concrete generalization	2B*	12	48.4%	
Early formal	3A	8	32%	40% Abstract thinking
Mature formal	3A/3B	2	8%	
Formal generalization	3B	0	0	-
Total		25	100%	-

Table 5. Cognitive development levels of Al-Aqsa students -first year (Science Education)

Developmental stage	symbol	Frequency No. of students	Percent	Abstract/ concrete
Mature Concrete	2B	2	7.7%	57.7% Concrete
Concrete generalization	2B*	13	50%	
Early formal	3A	9	34.6%	42.3% Abstract thinking
Mature formal	3A/3B	2	7.7%	
Formal generalization	3B	0	0	
Total		26	100%	100%

According to literature, most of the students in the university should have a formal thinking level. It is strange to find, that about 60% of the first year students of SE Department in the University are not capable of formal thinking.

Being only 42% of the students in the first year are capable of formal thinking may indicate that university students showed a delay in reaching the expected level of cognitive development or abstract thinking. Also, the result may indicate that the selection process of students in science Education Department is random and does not follow specific criteria to select the best candidates.

Question 2: What are the abstract thinking levels of the fourth –year students of science education in Al-Azhar and Al-Aqsa Universities?

The SRTs test was implemented on fourth- year students in SE Department in the two Universities. The Cognitive developmental levels of the samples are displayed in Table (6) and Table (7). It can be seen that 62 percent of the science education students at Al-Azhar are at the formal operational level (abstract level) , with the majority (51 percent) at the early formal (3A) level. There were only 7.2 percent at the Mature formal (3A/3B) level and 38 percent of the sample were at the concrete levels of cognitive development.

Table 6. Cognitive development levels of Al-Aqsa students -fourth- year students.

Developmental stage	symbol	Frequency/ No. of students	%	Abstract/ Concrete
Mature Concrete	2B	1	1.8%	38.2%
Concrete generalization	2B*	20	36.4%	
Early formal	3A	28	51%	61.8%
Mature formal	3A/3B	4	7.2%	
Formal generalization	3B	2	3.6%	
Total		55	100%	100%

There is 61.8% of the sample in fourth year in science in Al-Azhar University sample display formal operational thought, with the majority of these at the early formal (3A) level, and 11% in 3A/3B and 3B level.

Table 7. Cognitive development level (Profile) of Al-Aqsa fourth-year students.

Developmental stage	symbol	Frequency No. of students	Percent	Abst/ Concrete
Mature Concrete	2B	1	3.7%	33.4%
Concrete generalization	2B*	8	29.7%	
Early formal	3A	12	44.4%	66.6%
Mature formal	3A/3B	5	18.5%	
Formal generalization	3B	1	3.7%	
Total		27	100%	100%

In Al-Aqsa University, there were about 66.6% of the students having formal thinking (abstract thinking). Also, the percentage of students who had the concrete thinking level- was 33.4%. The percentage of the 3A/3B and 3B level is 22% (Table. 6). The percentage of abstract-thinker students in Al-Aqsa University is relatively higher than Al-Azhar University.

According to Piagetian levels, by the age of 14/15 years, most individuals should be at the formal operational level (abstract level). However, in Aqsa University

sample only 66.6% were at abstract level and 33.4 % were at the concrete level of cognitive development. The results may indicate that university students showed a delay in reaching the expected level of cognitive development or abstract thinking.

The current results are different from the results shown by McCormack et al, (2009) in Ireland. The profile obtained by McCormack showed that almost 70 % of students in the first year of the university were at levels capable of formal operational thought, while in Al-Aqsa or Al-Azhar universities the formal thinking did not exceed 66.6%.

In summary, the results of cognitive development profiles of the two Palestinian universities showed that the spread of thinking ability was wider than expected. The sample showed that 33.3% of the four year students were classified as concrete thinkers (as 12 year olds) and the remaining (66.7%) were classified as abstract thinkers, who demonstrated formal operational thinking.

The data of the Al-Azhar and Al-Aqsa universities indicated that the sample of university students tested was at cognitive developmental levels that were behind that expected for their age. That means majority of students were at levels which were insufficient for meaningful engagement and understanding of many Junior Certificate science and mathematics concepts. It is strange to find that: the late stages of abstract thinking (3B) was about 4%, which is highly under expected.

In Egypt, Ateewa (1985) showed that only 35% of the secondary school student had formal thinking level. In KSA , Magoshi (1990) reported that: only 30% of the first year students in college of education had formal thinking level. The best results of formal thinking level in the Arab Countries was in Bagdad (1987), where about 75% of the 12th grade students (18 years) had formal thinking level (Rasheed, 1988).

In UK, only 30% of the GSSC students (16 years) had formal thinking (Adey and Shayer, 1994). A more recent study by Ginsburg and Shayer (2007) showed that there was a large drop in their performance on cognitive tasks between 1975/76 and 2000/01 (Ginsburg and Shayer , 2007).

According to (Markwell & Courtney, 2006) the two levels which most college students operating at are concrete and formal operations. However, they stated that evidence suggests that close to half of entering college students are not operating at advanced stages of cognitive development and that postsecondary education plays a

key role in exposing students to experiences that encourage cognitive development. Woolfolk (2007) stated, “Some students remain at the concrete operational stage throughout their study years, even throughout life.

Question 3: Are there any statistical differences at ($\alpha \leq 0.05$ level) between the average score of Al-Azhar and Al-Aqsa first year students on Science Reasoning test (SRTs).

Hypothesis: The claim being investigated is that: "There are no statistical differences at ($\alpha \leq 0.05$ level) between the average score of Al-Azhar and Al-Aqsa first year students on Science Reasoning tasks (SRTs)".

Student t-Test was used to test this hypothesis. Table (8) shows that the significance value was 0.306. This show that there are no statistical differences at ($\alpha \leq 0.05$ level) between the average score of Al-Azhar and Al-Aqsa first year students on SRTs test.

Table 8. Student t-Test results, comparison between the means scores of Al-Azhar and Al-Aqsa students on SRTs test (1st year science students).

groups	N	Means	Standard Deviation	T-Value	Significance	
Al-Azhar	25	6.6640	.70763	1.035	.306	Not significant at level 0.05
Al-Aqsa	26	6.8846	.81765			

Question 4: Are there any statistical differences on ($\alpha \leq 0.05$ level) between the average score of Al-Azhar and Al-Aqsa fourth year students on Science Reasoning test (SRTs).

Hypothesis: The claim being investigated is that: There are no statistical differences at ($\alpha \leq 0.05$ level) between the average score of Al-Azhar and Al-Aqsa fourth year students on Science Reasoning Tasks SRTs.

Student t-Test was used to test this hypothesis. The significance values were 0.01 and, the t-value was 4.090 (Table.9). This shows that there is statistical differences at ($\alpha \leq 0.05$ level) between the average score of Al-Azhar and Al-Aqsa fourth year students on SRTs test. Al-Aqsa scores is better than Al-Azhar scores on the SRTs test.

Table 9. Student t-Test results, comparison between the means scores of Al-Azhar and Al-Aqsa students on SRTs test (4th year SE students)

groups	N	Means	Standard Deviation	T-Value	Significance	
Al-Azhar	55	7.1074	.6436	4.090	.01	significant on 0.05 level
Al-Aqsa	25	7.6640	.6518			

Question 6: Are there any statistical differences on ($\alpha \leq 0.05$ level) between the average score of first year students and the fourth year students on Science Reasoning test SRT.

Hypothesis: The claim being investigated is that: There are no statistical differences at ($\alpha \leq 0.05$ level) between the average score of first year students and the fourth year students on Science Reasoning Tasks SRTs.

In an analysis of the university- level differences in performance on SRT test by using t-Test, the results showed that there was a statistical significant difference at ($\alpha \leq 0.05$ level) between the average scores of the students in the two levels on the test (SRT). The average scores of the fourth- year students are higher than the first year students (Table. 10).

Table 10. Student t-Test results, comparison between the means scores of first and fourth year students on SRTs test

groups	N	Means	Standard Deviation	T-Value	Significance	
4th year	55	7.107	.6431	2.769	.007	significant at 0.01 level
1st year	25	6.66	.7076			

Comparing the two cohorts, 66.6% of the fourth year students display formal operational thought (abstract thought), while there is only 40% in the first year. An increase in the abstract thinking level of the students could be attributed to the university experience and the normal growth of the students. But the rate of the increase in abstract thinking level is still limited, compared to the expected in the fourth year.

Is there any statistical relationship between the average scores in SRT test and general achievement in science for fourth year students.

Hypothesis: The claim being investigated is that: There is no statistically significant relationship on ($\alpha \geq 0.05$ level) between the average score in SRT test and general achievement in science for fourth year students.

The study tried to investigate the nature of the relationship between the average scores in SRT test and general achievement in science for fourth year students (80 students). Pearson coefficient was used to investigate the relationship. The result is summarized in the following table:

Significance level	Correlation Value (r)
0.01	0.804

The results show that, the null hypothesis is rejected. That means, there is statistically significant relationship on ($\alpha \geq 0.01$ level) between the average score in SRT test and general achievement in science for fourth year students.

This current study attempted to gather evidence about the link between abstract thinking skills and success in Science discipline. The upper results show a positive correlation between the scores of the students in the abstract thinking test with the marks achieved in the university (GPA) in science. The ability to think abstractly has long been considered a core skill for study in many sciences. However, the small numbers of students in the current study mean that wider research is needed.

There has been some research interest in gathering evidence of a link between abstract thinking and achievement in science (Armoni M, Gal-Ezer, 2007; Bennedsen, Caspersen. 2006). Robert (2010) and Kramer (2007) gathered evidence about the link between abstraction skills and success in the Computer Science (CS) discipline. This evidence may be used to improve the quality of education and selection process in the university. Conceptually there appears to be a more direct link between the logical use of symbols related to abstract concepts and many aspects of Science.

Conclusion and Implications

In general, the percentage of students who showed capability of formal operational thought is limited. This study yielded a profile of cognitive levels of students that

choose to study science-education at the first year and in the fourth year in two Palestinian universities.

The study showed that, the proportion of the sample of students that displayed formal operational thought (abstract thinking) did not exceed 67% in fourth year and 42% in the first year. The percentage of students who have late formal operational thinking level is limited or absent. The percentage of students who have concrete thinking level is about 60% in the first year students and at least 33% in the fourth year.

The education literature confirms that formal operational thought is necessary for meaningful engagement and understanding of many scientific and mathematical concepts.

The fourth year students in Al-Azhar University have proceeded through next levels without fully developing their full cognitive abilities (Still there is 37% of the science students, who have concrete thinking level). The students perhaps did not interact with the content of the science course and yet despite this, they successfully completed the course. That may reflect the nature of some examinations in the universities which may depend on rote learning. Otherwise, the concrete thinker students would have failed if they had problem-solving examinations.

Consequently, all results of cognitive development for the first year and the fourth year student may indicate the poor selection of future science teachers. Also, it is difficult to explain the limited development rate in students' thinking skills through four years of university study (41% to 67%). The current systems in the College of Education may have not succeeded in aiding Science students to reach their potential in terms of cognitive ability through four years of teachers preparation program.

In science program, Al-Aqsa University results in the fourth year are better than Al-Azhar. Does that mean the preparation program is better? Or have Al-Aqsa University succeeded in selecting its science students? It is difficult to answer now, that needs more studies in the field.

However, some studies eliminated the overall effect of preparation program (including curricular and co-curricular activities) inside University on cognitive development of students and concentrated more on an appropriate selection process

of candidates (Bowman, 2010). Literature showed a successful intervention program to raise abstract thinking level of students, which was done in several places in the world.

The intervention approach considered the college years as a time of significant growth and change for students cognitive development as they confront new ideas and experiences that may challenge what they already know and believe. Faculty members who understand these changes can design courses and activities that meet students' needs and support their continued development.

Recommendations

The findings of the current study should be of a major concern for different parties on a number of levels of decision makers: universities, schools, and Ministry of Education. In the light of the findings, the current study recommends the following points:

- It is necessary to develop selection process to have better candidates for the science teachers in the future. By following specific criteria, Colleges will be able to shortlist applicants in a highly effective way.
- This study highlights the need for science instructor (teacher) who has better understanding of cognitive developmental of his students to cope with teaching challenges in science. She/he should have better understanding of the cognitive developmental profile of their students and their capabilities. This may help teachers to design more effective instructional material for teaching science.
- It is necessary to develop the Teacher Preparation Program in the Palestinian universities to enhance the student teachers to use thinking skills in teaching. Colleges of Education should design courses and activities that meet students' needs and support their continued cognitive development.

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